

WHAT IS CLAIMED IS:

1. An electronic control unit having a monitoring control circuit comprising: a non-volatile program memory, an operation processing RAM memory, an input interface circuit to which an input sensor group is connected, an output interface circuit to which an electrical load group is connected, and a microprocessor controlling the mentioned electrical load group responsive to a content of a control program that is stored in said non-volatile program memory, and an operation state of said input sensor group;

wherein the electronic control unit further comprises:

a monitoring control circuit section that is connected to said microprocessor via a pair of serial interface circuits, and includes inquiry packet transmission means for sequentially transmitting regularly question information to said microprocessor; correct answer information storage means to said question information; and error determination means for comparing answer information based on said question information with correct answer information that is stored in said correct answer information storage means to determine presence or absence of any error; and

under-monitoring processing means that is an under-monitoring processing program stored in said non-volatile program memory in addition to the control program for input/output control, and includes: simulation-operation-execution processing means that is executed based on the question information having been transmitted by said inquiry packet transmission means; response packet transmission means for transmitting an execution result of said simulation-operation-execution processing means as an answer information

to said monitoring control circuit section; and receiving interval error processing means that is reverse monitoring means for restarting, or alarming and stopping said monitoring control circuit section when a receiving interval of said inquiry packet is abnormal; and

wherein, an under-test target program that is contained in said control program and a simulation-operation-execution processing program serving as simulation-operation-execution processing means and contained in said under-monitoring processing program include at least some common programs.

2. The electronic control unit having the monitoring control circuit according to claim 1, wherein said simulation-operation-execution processing program includes an input data table, said under-test target program and said simulation-operation-execution processing program are carried out alternately, and input data to be processed in said simulation-operation-execution processing program are selected in sequence from said input data table corresponding to a content of said inquiry packet.

3. The electronic control unit having the monitoring control circuit according to claim 1, wherein said under-test target program is divided into a plurality of groups; said simulation-operation-execution processing program relative to each group includes an input data table corresponding to said processing program; and said inquiry packet selects one input data group from the whole of said input data tables, and then sequentially selects the subsequent input data group after said simulation-operation-execution processing program to which a

selected input data group belongs and each said under-test target program has been carried out.

4. The electronic control unit having the monitoring control circuit according to claim 1, wherein said non-volatile program memory includes: said control program for an input/output control having been transferred and written from an external tool that is serially connected via a tool interface circuit; said under-monitoring processing program acting as said under-monitoring processing means; and a correct answer information data to a question information, and said correct answer information data are transferred again to said correct answer information storage means that is provided in said monitoring control circuit section.

5. The electronic control unit having the monitoring control circuit according to claim 1, wherein said monitoring control circuit section includes an auxiliary microprocessor comprising an auxiliary program memory and an auxiliary RAM memory; said auxiliary program memory is storage means of a program corresponding to said inquiry packet transmission means and said error determination means; and said auxiliary RAM memory is storage means of a correct information that has preliminarily been stored in said non-volatile program, and is transferred and written at the time of starting operation to be applied in said auxiliary microprocessor; and

said auxiliary microprocessor carries out said transmission of an inquiry packet and said error determination in cooperation with said auxiliary program memory, and carries out transfer processing of correct information to said

auxiliary RAM memory in cooperation with said microprocessor.

6. The electronic control unit including the monitoring control circuit according to claim 1, wherein said microprocessor replies a response packet corresponding to a content of a last  $n-1$ th inquiry packet immediately after receiving a  $n$ th inquiry packet having been transmitted from said monitoring control circuit section; and replying said response packet also functions as recognition information relative to having received said  $n$ th inquiry packet.

7. The electronic control unit including the monitoring control circuit according to claim 6, wherein said under-monitoring processing means includes transmission means of a first synchronization packet that is transmitted to said monitoring control circuit section, and that contains information permitting or inhibiting for said monitoring control circuit section to regularly transmit said inquiry packet; and

wherein said monitoring control circuit section includes monitoring permission error processing means that acts when said monitoring control circuit section is incapable of getting a regular transmission permission with said first synchronization packet, and carries out any one of alarm and stop, restart, and alarm display.

8. The electronic control unit including the monitoring control circuit according to claim 7, wherein said under-monitoring processing means includes transmission means of a second synchronization packet that is transmitted to said

monitoring control circuit section, and functions as recognition means for recognizing the receiving of a first inquiry packet of a first cycle that said monitoring control circuit section has transmitted; and

a response packet responsive to the last inquiry packet is replied when the first inquiry packet of the next cycle has been received.

9. The electronic control unit having the monitoring control circuit according to claim 1, wherein said monitoring control circuit section includes receiving-confirmation means for discriminating whether it is a normal receiving or a non-normal receiving with a determination result of lack or mix in bit information of at least response packets that are transmitted from said microprocessor out of various received packets, and further includes an error counter having a predetermined initial value; and

wherein subtracting or adding count is performed until a current value of said error counter reaches a predetermined normal side limit value when receiving of said receiving-confirmation means is discriminated normal, and adding or subtracting count of the current value of said error counter is performed by a plurality of counts in a direction different from that of said normal side limit value when a content of the response packet is discriminated incorrect by said error determination means even if the normal receiving is discriminated; and said microprocessor is restarted, or alarmed and stopped when a current value of said error counter gets out of a predetermined error side limit value.

10. The electronic control unit having the monitoring control circuit according to claim 9, wherein said inquiry packet contains current value information of said error counter; and

wherein said non-volatile program memory comprises a program acting as:

incorrect answer transmission selection means that acts when a current value of said error counter is within a predetermined tolerance, and transmits said response packet, which is an intentionally incorrect answer not corresponding to a content of the last inquiry packet; and

current value monitoring means functioning as reverse monitoring means for monitoring whether or not said monitoring control circuit section recognizes that an incorrect answer has been received and that a current value of said error counter is increased or decreased, and for restarting, or alarming and stopping said monitoring control circuit section when said error determination means of said monitoring control circuit section is not operated normally.

11. The electronic control unit having the monitoring control circuit according to claim 9, wherein said non-volatile program memory includes incorrect answer transmission determination means that is a program that acts when a content of said inquiry packet having been received from said monitoring control circuit section is lack or mix in error of bit information, and the program determines that a content of said response packet to be transmitted subsequently is a predetermined incorrect answer.

12. The electronic control unit including the monitoring control circuit according to claim 1, wherein said monitoring control circuit section includes:

receiving-confirmation-response means that carries out discrimination between normal receiving and non-normal receiving with a determination result of lack and mix in bit information of at least said response packets to be transmitted from said microprocessor out of various received packets, and selects a normal confirmation packet or a non-normal confirmation packet in accordance with said determination result to reply it to said microprocessor; and

response interval error processing means that acts when a response packet is not replied from said microprocessor even if a predetermined time period has passed from transmission of said inquiry packet or when said non-normal receiving continues, and restarts, or alarms and stops said microprocessor;

wherein said non-volatile program memory includes a processing program that acts as retransmission processing means by which the microprocessor having received said non-normal confirmation packet transmits said response packet again; and acts as confirmation reply error processing means that acts when a time period from transmitting said response packet to receiving a normal confirmation packet exceeds a predetermined value, and restarts, or alarms and stops said monitoring control circuit section.

13. An electronic control unit having a monitoring control circuit comprising: a non-volatile program memory, an operation processing RAM memory, an input interface circuit to which an input sensor group is connected, an output interface circuit

to which an electrical load group is connected, and a microprocessor controlling said electrical load group responsive to a content of said non-volatile program memory, and an operation state of said input sensor group;

wherein the electronic control unit further comprises:

a monitoring control circuit section that is connected to said microprocessor via a pair of serial interface circuits, and includes inquiry packet transmission means for sequentially transmitting regularly question information to said microprocessor; correct answer information storage means to said question information; and error determination means for comparing answer information based on said question information with correct answer information that is stored in said correct answer information storage means to determine presence or absence of any error; and

under-monitoring processing means that is an under-monitoring processing program stored in said non-volatile program memory and includes: simulation-operation-execution processing means that is executed based on the question information having been transmitted by said inquiry packet transmission means; response packet transmission means for transmitting an execution result of said simulation-operation-execution processing means as an answer information to said monitoring control circuit section; receiving interval error processing means that is reverse monitoring means for restarting, or alarming and stopping said monitoring control circuit section when a receiving interval of said inquiry packet is abnormal; and

a watchdog timer that generates a reset pulse signal when a pulse width of a watchdog signal, being a pulse train that



said microprocessor generates, exceeds a predetermined value to restart, or alarm and stop said microprocessor and said monitoring control circuit section; and

wherein operation of said microprocessor is monitored by said watchdog timer and said monitoring control circuit section, and said microprocessor monitors in reverse monitoring control operation of said monitoring control circuit section.

14. The electronic control unit having the monitoring control circuit according to claim 13, wherein said non-volatile program memory includes: said control program for an input/output control having been transferred and written from an external tool that is serially connected via a tool interface circuit; said under-monitoring processing program acting as said under-monitoring processing means; and a correct answer information data to a question information, and said correct answer information data are transferred again to said correct answer information storage means that is provided in said monitoring control circuit section.

15. The electronic control unit having the monitoring control circuit according to claim 13, wherein said monitoring control circuit section includes an auxiliary microprocessor comprising an auxiliary program memory and an auxiliary RAM memory; said auxiliary program memory is storage means of a program corresponding to said inquiry packet transmission means and said error determination means; and said auxiliary RAM memory is storage means of a correct information that has preliminarily been stored in said non-volatile program, and is transferred and written at the time of starting operation to

be applied in said auxiliary microprocessor; and

said auxiliary microprocessor carries out said transmission of an inquiry packet and said error determination in cooperation with said auxiliary program memory, and carries out transfer processing of correct information to said auxiliary RAM memory in cooperation with said microprocessor.

16. The electronic control unit including the monitoring control circuit according to claim 13, wherein said microprocessor replies a response packet corresponding to a content of a last  $n-1$ th inquiry packet immediately after receiving a  $n$ th inquiry packet having been transmitted from said monitoring control circuit section; and replying said response packet also functions as recognition information relative to having received said  $n$ th inquiry packet.

17. The electronic control unit including the monitoring control circuit according to claim 16, wherein said under-monitoring processing means includes transmission means of a first synchronization packet that is transmitted to said monitoring control circuit section, and that contains information permitting or inhibiting for said monitoring control circuit section to regularly transmit said inquiry packet; and

wherein said monitoring control circuit section includes monitoring permission error processing means that acts when said monitoring control circuit section is incapable of getting a regular transmission permission with said first synchronization packet, and carries out any one of alarm and stop, restart, and alarm display.

18. The electronic control unit having the monitoring control circuit according to claim 13, wherein said monitoring control circuit section includes receiving-confirmation means for discriminating whether it is a normal receiving or a non-normal receiving with a determination result of lack or mix in bit information of at least response packets that are transmitted from said microprocessor out of various received packets, and further includes an error counter having a predetermined initial value; and

wherein subtracting or adding count is performed until a current value of said error counter reaches a predetermined normal side limit value when receiving of said receiving-confirmation means is discriminated normal, and adding or subtracting count of the current value of said error counter is performed by a plurality of counts in a direction different from that of said normal side limit value when a content of the response packet is discriminated incorrect by said error determination means even if the normal receiving is discriminated; and said microprocessor is restarted, or alarmed and stopped when a current value of said error counter gets out of a predetermined error side limit value.

19. The electronic control unit having the monitoring control circuit according to claim 18, wherein said inquiry packet contains current value information of said error counter; and

wherein said non-volatile program memory comprises a program acting as:

incorrect answer transmission selection means that acts

when a current value of said error counter is within a predetermined tolerance, and transmits said response packet, which is an intentionally incorrect answer not corresponding to a content of the last inquiry packet; and

current value monitoring means functioning as reverse monitoring means for monitoring whether or not said monitoring control circuit section recognizes that an incorrect answer has been received and that a current value of said error counter is increased or decreased, and for restarting, or alarming and stopping said monitoring control circuit section when said error determination means of said monitoring control circuit section is not operated normally.

20. The electronic control unit including the monitoring control circuit according to claim 13, wherein said monitoring control circuit section includes:

receiving-confirmation-response means that carries out discrimination between normal receiving and non-normal receiving with a determination result of lack and mix in bit information of at least said response packets to be transmitted from said microprocessor out of various received packets, and selects a normal confirmation packet or a non-normal confirmation packet in accordance with said determination result to reply it to said microprocessor; and

response interval error processing means that acts when a response packet is not replied from said microprocessor even if a predetermined time period has passed from transmission of said inquiry packet or when said non-normal receiving continues, and restarts, or alarms and stops said microprocessor;

wherein said non-volatile program memory includes a

processing program that acts as retransmission processing means by which the microprocessor having received said non-normal confirmation packet transmits said response packet again; and acts as confirmation reply error processing means that acts when a time period from transmitting said response packet to receiving a normal confirmation packet exceeds a predetermined value, and restarts, or alarms and stops said monitoring control circuit section.